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RESEARCH UPDATE

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Alcohol, Drugs, and the Brain

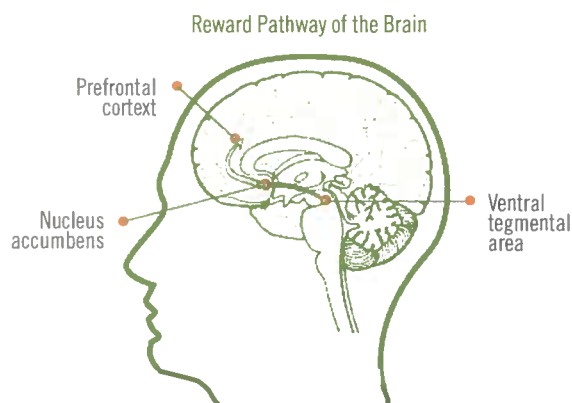
Alcohol and other drugs affect the brain in three ways: (1) immediately, in altering perceptions or emotions; (2) after repeated use, laying the stage for dependence by producing symptoms of tolerance and withdrawal, and (3) after chronic use, resulting in neurological damage.

Immediate Effect of Intake

All mood-altering chemicals have an immediate effect on the brain. Alcohol and other drugs affect neurotransmitters, the molecules that carry messages from one nerve ending to another. Dopamine is one of the primary neurotransmitters that is involved in the addiction to drugs and at this point in time, is best understood. Dopamine is the neurotransmitter that is associated with feelings of well-being, and plays a role in cognition and movement.¹ Mood-altering drugs change dopamine levels in the synapses (the area between nerve endings), but in different ways.² For example, alcohol causes dopamine to increase. Interestingly, even anticipating alcohol increases dopamine levels in animal studies.³ Amphetamines increase release of dopamine by blocking the molecule that would normally transport it away.⁴ New research is identifying the role that specific brain proteins play in cocaine's impact on dopamine receptors.⁵

Another neurotransmitter, serotonin, is thought to play an important role in the brain's reaction to alcohol. Recent research suggests that in complex ways, individuals with dysfunctional serotonin activity may be more prone to developing alcoholism.⁶

Any effect on dopamine transmission in the brain occurs in the context of an extremely complex system which includes over one trillion nerve cells and a host of other neurotransmitters, amino acids, and hormones, all of whose action are affected by genetics, normal body rhythms, and environmental stimuli in addition to the mood-altering substances.¹ For example, researchers have amassed a large body of research uncovering specific proteins in the brain (gamma-aminobutyric acid or GABA, glycine, and glutamate) that influence nerve cells' overall level of activity and ability to fire impulses. Simply put, GABA and glycine inhibit nerve cell firing whereas glutamate increases or excites nerve cells, increasing their firing. Alcohol and other sedative-hypnotics such as Valium and barbiturates affect these receptor proteins.⁷



SOURCE: From the National Institute on Drug Abuse website, Mind Over Matter Teachers Guide.

THE HAZELDEN EXPERIENCE

All patients entering treatment in Hazelden's residential treatment programs receive screening tests for neuropsychological damage associated with alcohol/drug use. Many patients, show some impairment in abstract thinking and problem solving at the beginning of treatment. Cognitive ability is monitored and program adaptations are made to accommodate impairment or patients are referred for further assessment and treatment. With abstinence, most patients begin to show significant improvement in cognitive function during treatment.

CONTROVERSIES & QUESTIONS

Question: How long does brain damage last?

Response: It depends on the quantity, and the length of time a substance is used, as well as the type of substance. For example, long-term use of alcohol changes the actual structure of the brain, shrinking some areas through loss of nerve cells and resulting in loss of brain weight.¹ With long-term abstinence, the brain can recover, both structure and function.^{16, 17, 18}

Question: Why is addiction called a "brain disease?"

Response: Addiction is referred to as a brain disease for two reasons: (1) all drugs have a direct and immediate impact on the brain, at both a structural and cellular level, producing changes in the reward system pathway; (2) most importantly, "prolonged drug use causes pervasive changes in brain function that persist long after the individual stops taking the drug."⁹

HOW TO USE THIS INFORMATION

Carry the message that alcohol and other drugs exert their effect via short- and long-term effects on the brain. They can cause subtle neuroadaptations on the cellular level, leading to the development of tolerance, withdrawal, and ultimately addiction.

Healthcare providers who treat patients presenting with unexplained cognitive impairment need to consider alcohol or other drug use as a causative factor.

Alcohol, Drugs, and the Brain



While every cell of the brain—and whole body—is affected by alcohol and drugs, the area of the brain called the amygdala is thought to be responsible for the reinforcing effects of the drug. Specifically, the section of the meso-limbic system called the nucleus accumbens is often referred to as the reward pathway of the brain, and this is where dopamine seems to have its greatest impact.¹ (See Figure.)

Long-term Effect of Drugs

Over time, drugs change the brain. This process is referred to as neuroadaptation.^{1,8,9} In other words the brain becomes “accustomed” to the influence of a drug, and changes the way it works to accommodate the action of the drug. For example, in response to a chronic flood of neurotransmitters, the brain decreases the number of receptors in the nerve cells. Consequently, even more drugs are needed to compensate for the brain’s attempt to normalize itself. After repeated exposure to a drug, tolerance can develop, meaning that the person can “tolerate” increased amounts of the drug before showing the expected behavioral effects. When the drug is withdrawn, brain cells react, producing withdrawal symptoms.

Neurotoxic Effects

With chronic use and/or heavy use, alcohol and drugs can damage the brain. For example, while the most common cause of dementia is Alzheimer’s disease, alcohol use is the second-leading cause of dementia.¹⁰ Inhalant use can produce general brain damage with severe cognitive dysfunction, problems in vision and hearing, and impaired movement.^{11,12} Stimulants, including methamphetamine and cocaine, produce changes in the brain’s arterial structures, probably through increased blood pressure, making cerebral hemorrhages more likely.^{4,13} Methamphetamine damages nerve cells containing dopamine, and kills other nerve cells.¹⁴ Wernicke-Korsakoff’s syndrome is one type of dementia associated with long-term alcohol use and the nutritional deficiencies that often accompany alcoholism. It is characterized by inability to learn new information. For example, a person may not be able to recall people or places that they just visited moments before.¹ To compensate, a person may confabulate, or create scenarios to fill in the missing information.¹⁵ In addition to reducing cognitive function, chronic alcohol use may produce personality changes. Impairment of the frontal lobe of the brain, for example, reduces impulse control, which can result in impulsive or violent behavior.¹

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The Butler Center for Research informs and improves recovery services and produces research that benefits the field of addiction treatment. We are dedicated to conducting clinical research, collaborating with external researchers, and communicating scientific findings.

Patricia Owen, Ph.D., Director

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